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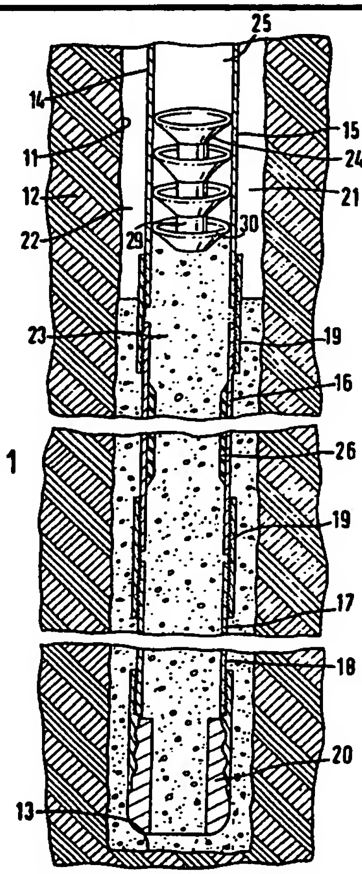
(54) Cementing well bores

(57) A casing joint 16 connected in a casing string in a well bore 11 includes a rubber lining 26 forming obstruction means for interrupting the passage of a fluid displacement plug 24 during a cementing operation in the well bore. The displacement plug 24 is driven down the casing string by displacement fluid 25 and forces cementing fluid 23 ahead of the plug and back up the outside of the casing string. When the plug 24 reaches the lining 26 a pressure surge is detected at the pumping operation. The detection of plug position is used to indicate termination or near termination of cementing, or to calibrate the pumping mechanism.

FIG. 1



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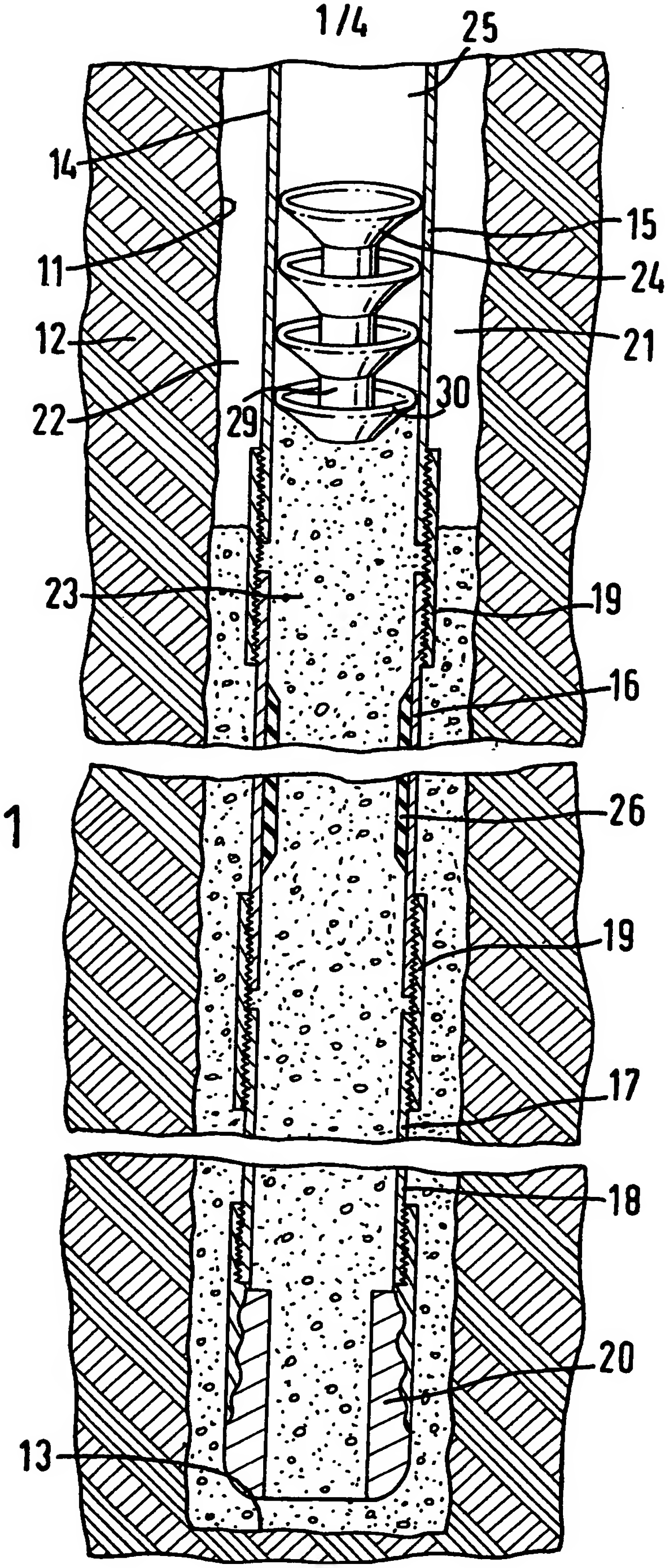

FIG. 1

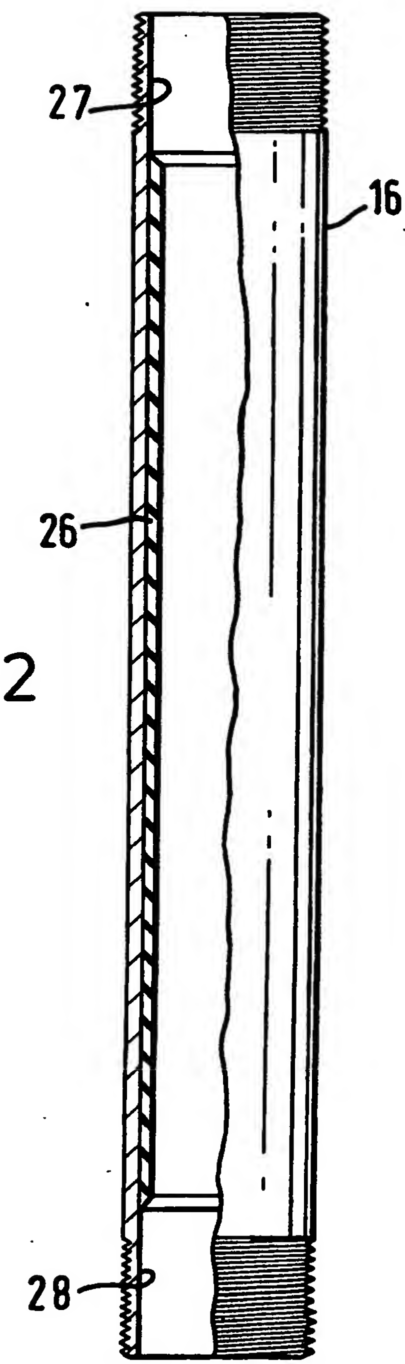

FIG. 2

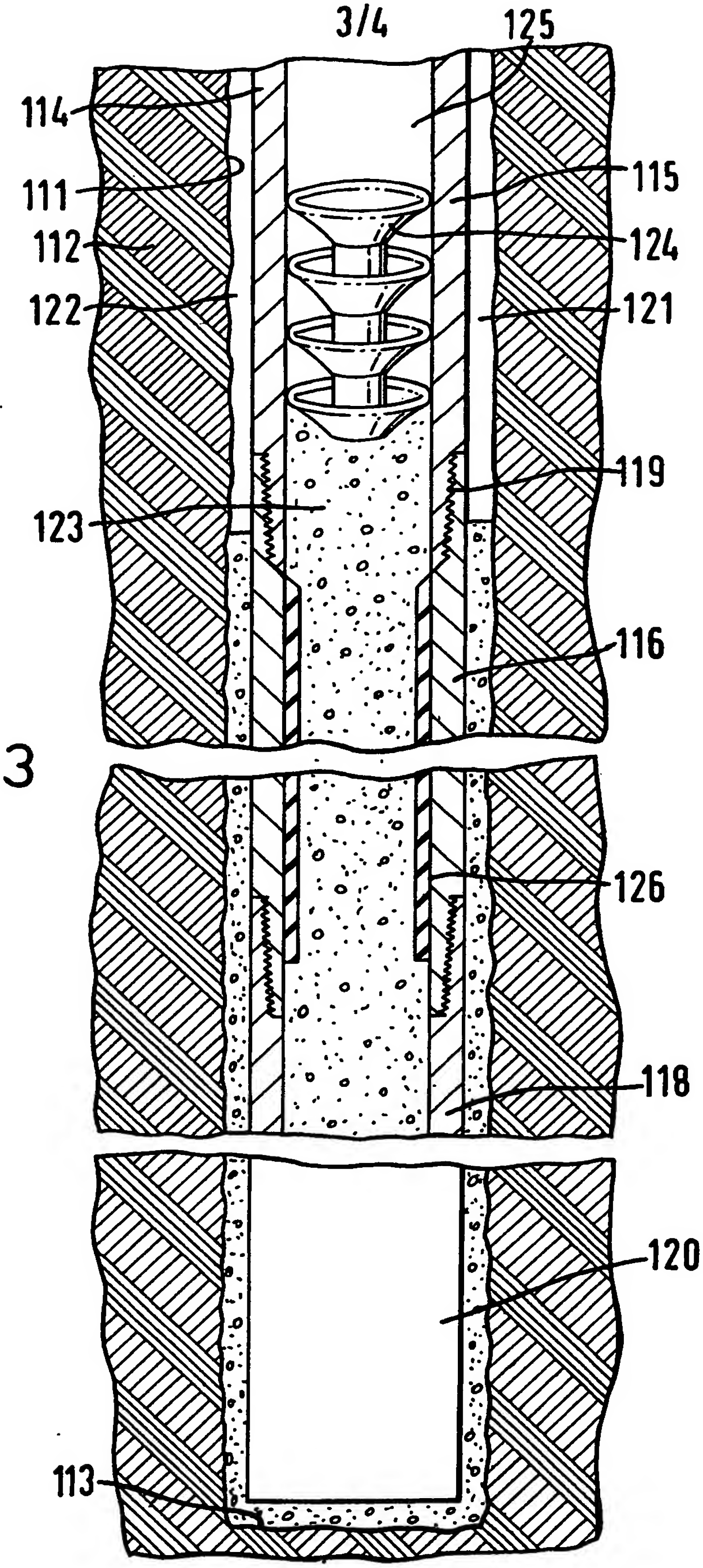

FIG. 3

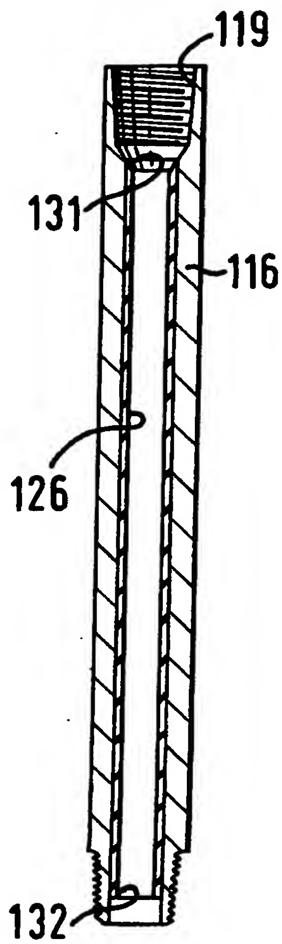

FIG. 4

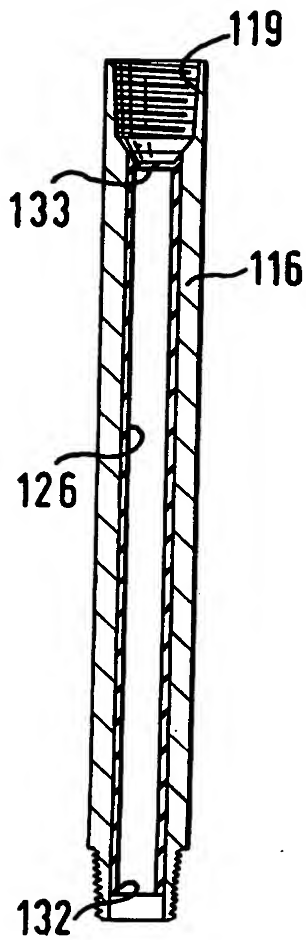

FIG. 5a

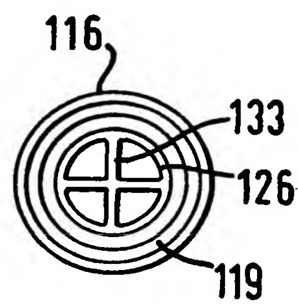

FIG. 5b

SPECIFICATION

Improvements in and relating to pumping fluids in well bores

The present invention relates to pumping fluids in well bores, and is concerned in particular but not exclusively with methods for use in connection with cementing operations in tubular structures in well bores, and component for use in such methods.

Operations occuring in the drilling of bores for wells such as oil, gas or water wells, include the cementing into the bore of a hollow cylindrical steel casing formed of a series of lengths of casing known as casing joints, joined together to give a continuous casing known as a casing string. The cementing process normally occurs at the end of drilling of each stage of the bore of the well, or formation as the bore is known. When a stage of the well has been drilled as far as possible without danger of collapse of the formation, the drill string is removed and is replaced by a casing string having an outer diameter less than the formation. During the removal of the drill string and insertion section by section of the casing string, the formation is maintained by the weight of a packing fluid containing for example barium sulphate among other constitutents. This fluid is pumped down the drill and up to the surface during drilling to carry away the cuttings, cool the bit and hold back the pressure from the formation (among other functions), and is retained in the formation while the casing is placed in the bore.

When the casing string is in position it is cemented in place by pumping down the hollow centre of the casing a cementing fluid which usually comprises a cement and water slurry. The cementing fluid displaces the packing fluid and passes out of the casing string at the bottom of the bore and is forced back up the outside of the casing string to displace packing fluid from the annular space between the outer wall of the casing and the inside of the bore. The bottom of the casing is terminated by an element known as a float shoe or float valve resting at the bottom of the formation.

Ideally, just sufficient cementing fluid is pumped into the casing to fill the annular space around the casing back to the required height (which may be to the top of the formation) with virtually no cement in the bottom of the inside of the casing. This operation is attempted by placing in the casing string above a calculated quantity of cementing fluid a fluid displacement plug which is driven along the casing string by pumping a displacement fluid under pressure behind the plug. The displacement fluid may be similar to the packing fluid, for example a slurry of water, barium sulphate and other materials. Thus the cementing fluid is carried along in front of the plug and the displacement fluid behind the plug is pumped under pressure to drive the plug along.

Considerable skill is required during the cementing operation to decide when to stop pumping the displacement fluid behind the plug so as to stop the operation as nearly as possible when the plug has just reached the bottom of the casing string. If pumping continues after the plug reaches the bottom of the casing string, displacement fluid is pumped beyond the end of the casing string to displace the cementing fluid from its proper position around the outside of the casing and also to cause damaging mixing with the cementing fluid so preventing proper setting of the cement. Such an occurrence is known as overdisplacement. If the converse occurs, and pumping is discontinued before the plug reaches the bottom of the casing, the cement sets in the casing and has to be drilled out again at a later stage before the next stage of drilling the formation can commence. Clearly such extra drilling is time consuming and expensive.

In order to attempt to estimate when the displacement plug should have reached the bottom of the casing, the present practice is to calculate the volume of displacement fluid needed to be pumped into the casing to fill the hollow inside of the casing and to carry the plug to the bottom, and then to make an estimate of the volumetric efficiency of the displacing pump and the overall integrity of the displacing system (i.e. valves, casing, joins and so on). It is then attempted to pump in the calculated volume of displacement fluid by counting pump strokes and relating the count to the estimated performance of the pump, endeavouring to make allowance for leakage in the pipes, valves and other parts of the pumping system.

Premature grounding of the plug can be detected by detecting a surge of pressure in the surface pumping system, but by that time the damage has usually taken place by overdisplacement of the cementing fluid. It is known practice to detect the occurence of unwanted activity in a well bore by detecting a pressure change in the pumping system, and this is used for example to detect a blocked jet in the cleaning fluid supply to a drilling head, or to detect a cave-in or other fault in a formation. However, such prior use of monitoring the pressure in the pumping system has only detecting unwanted accidental occurences after the stage when damage has occured.

During the cementing process, if the displacement plug does not seat and seal at the float valve when the precalculated total displacement volume has been pumped, then it is common practice to stop displacement for fear of overdisplacing the cement. Over dis-

placement of cement, or to be more specific unintentionally displacing all of the mixed cement outside of the casing, gives rise to many problems and is a situation that drilling supervisors try to avoid. In being too cautious of overdisplacement, underdisplacement sometimes occurs, whereby too much cement is left inside the casing. The rig time involved in drilling out an excessive amount (i.e. up to about 5,000 ft.) of set cement from time to time can be costly to the operator. There is no practical and accurate subsurface method or equipment being used in the industry to determine the overall volumetric efficiency of the displacing system prior to seating the plug while cement displacing is in progress.

Another form of cementing operation in which similar problems arise is the operation of cementing the bottom of a well bore at a stage of the drilling operation itself. When, in presently known methods, it is desired to cement the bottom of a well bore after a stage of drilling has been completed (but before a casing string is inserted), cement is pumped down the hollow centre of the drill pipe or string and is forced back up the outside of the drill pipe in a similar manner to that described for a casing string. At present the cement is forced down the drill pipe by a following displacement fluid, but no plug is used to separate the cement and the displacement fluid. After the cement has been pumped into position (so far as can be estimated by the techniques described above) the drill pipe is withdrawn, leaving the cement at the bottom of the well bore to set as required.

In addition to the problems of overdisplacement and underdisplacement described previously with regard to cement casing strings, the pumping of cement through a drill pipe brings an additional problem. When the pumps are turned off before withdrawing the drill pipe, the weight of cementing fluid around the outside of the drill pipe is greater than the weight of displacement fluid inside the drill pipe, and often this causes the cementing fluid to flow back down the outside of the drill pipe and up into the hollow centre of the drill pipe. This effect, known as a "U-tube" effect, may result in cement remaining in the drill pipe after withdrawal, with consequent difficulties of operation in subsequent drilling.

It is a main object of the present invention to provide a method (and components for use in such a method) of carrying out cementing operations in well bores in tubular structures such as casing strings or drill pipes in which the risk of overdisplacement or underdisplacement of cementing fluid is reduced or eliminated.

It is another object of the invention, in certain aspects thereof, to provide a method (and components for use in such a method) of cementing the base of a well bore by pumping cementing fluid down a drill pipe, in which the risk of significant return of cementing fluid into the drill pipe is reduced or eliminated.

In accordance with the present invention there is provided a method of monitoring the pumping of fluid along a tubular structure in a bore of a well, comprising the steps of driving a movable plug member along a tubular structure in a bore of a well by a pumping system pumping fluid under pressure behind the plug member, interrupting the passage of the plug member along the tubular structure by an obstruction means placed at a known distance along the tubular structure, and detecting a surge of pressure in the pumping system resulting from the said interruption of the movement of the plug member to indicate the position of the plug member at the time of detection of the pressure surge.

The plug member may conveniently be formed by a fluid displacement plug suitable for displacing cementing fluid along the tubular structure. For convenience in the subsequent description the plug member will sometimes be referred to as a plug.

By way of example, the tubular structure may comprise the hollow cylindrical structure used to drive a drill during the drilling process and known as a drill pipe or drill string. As a further example, the tubular structure may comprise a hollow cylindrical structure used to line a completed or partly completed well bore and known as a casing string. Tubular structures such as drill pipes and casing strings are generally referred to in the field of drilling as "tubulars" and the present invention finds use in operations in such "tubulars".

The interruption of the plug movement is conveniently a momentary check of the movement of the plug which may be may not bring the plug to rest before resuming its movement under the build up of pressure.

The method described has particular use in the cementing processes set out above, and may be used merely to give an indication that a displacement plug is approaching the bottom of a casing string or drill pipe, or, as will be described hereinafter, to calibrate the pumping system. Conveniently the method may be used both to give a forewarning of the end of the displacement process and to calibrate the system.

In this specification it is to be appreciated that the term fluid means any liquid, semi-liquid slurry or other flowable material of the kind used in pumping operations in well bores. The invention has application in many kinds of land or off-shore oil, gas or water wells and many different fluids are used in such systems.

There is also provided in accordance with the present invention a method of calibrating a pumping system for pumping fluid along a tubular structure in a bore of a well compris-

ing the steps of driving a fluid displacement plug along a tubular structure in a bore of a well from a known reference position by pumping displacement fluid under pressure behind the plug, interrupting the passage of the plug along the tubular structure at a known distance from the said reference position, detecting a surge of pressure in the pumping system resulting from the interruption of the passage of the plug, and measuring a working parameter of the pumping system from the time of plug movement from the said reference position to the time of detection of the said pressure surge to provide a measure of the said working parameter related to a known volume of displacement fluid corresponding to the said known distance along the tubular structure.

Conveniently the said known reference position of the plug is constituted by the top of the tubular structure at the surface of the bore, so that the working parameter of the pumping system is measured from the time that the plug is inserted in the tubular structure and the pumping operation started. Usually the measurement of working parameter referred to will be a count of pump strokes. It will be appreciated that once a relationship has been established in operating conditions between a count of pump strokes and a volume of displacement fluid which has taken the plug to the obstructing means, it is a simple matter to calculate how many further pump strokes will be needed to carry the plug the remaining distance to the bottom of the tubular structure, or other required position.

In accordance with one particular aspect of the invention there is provided a method of carrying out a cementing operation in a bore of a well comprising the steps of forcing cementing fluid along a tubular structure by a fluid displacement plug driven along the tubular structure by a pumping system pumping a displacement fluid under pressure behind the plug, interrupting the passage of the plug along the tubular structure by an obstruction means placed at a known distance along the tubular structure, detecting a surge of pressure in the pumping system resulting from the said interruption of the plug movement to indicate the position of the plug, and terminating the cementing operation in dependence upon the detection of the said pressure surge.

There is further provided in accordance with the present invention a tubular component for use in a tubular structure in a bore of a well, the tubular component having obstruction means for interrupting passage through the tubular component of a plug member during pumping of fluid through the tubular component.

Where the tubular structure comprises a casing string, the tubular component may consist of a casing joint, which term means a length of casing adapted to be joined with other lengths of casing to form a casing string for use in a bore of a well. Where the tubular structure comprises a drill pipe, the tubular component may consist of a corresponding joint of the drill pipe or string. Hereinafter such tubular components will be referred to generally as tubular joints or merely as joints.

In one particularly preferred form of the obstruction means for use in a drill pipe, the obstruction means may have a shape such as to allow a fluid displacement plug to move past the obstruction means under the force of displacement fluid behind the plug, but such as to prevent return of the plug back up the drill pipe under the force of cementing fluid displaced outside the drill pipe. Such a use of an obstruction means embodying the invention may be used to reduce or avoid the "U-tube" effect described hereinbefore as a disadvantage of known cementing operations.

In some aspects of the invention an obstruction means may be used in a cementing operation in a drill pipe or other tubular structure as set out in the previous paragraph without being used to determine a finishing time for the cementing operation.

Thus in accordance with a different aspect of the invention there is provided a method of depositing cement in a bore of a well comprising the steps of forcing cement fluid along a tubular structure by a fluid displacement plug driven along a tubular structure by a pumping system pumping a displacement fluid under pressure behing the plug, and driving the plug past an obstruction means placed in the tubular structure at or in the region of the bottom of the well bore and having a shape such as to prevent or inhibit return of the plug along the tubular structure past the obstruction means.

There is further provided in accordance with the present invention in this aspect a tubular component for use in a tubular structure in a bore of a well, the tubular component having obstruction means shaped to allow passage through the tubular component of a fluid displacement plug during pumping of fluid through the tubular component, but shaped to prevent or inhibit return of the plug past the obstruction means under the influence of fluid displaced from the tubular structure by the plug.

Preferably the obstruction means is adapted for disposal after the said interruption of the cement displacement plug, conveniently the obstruction means being adapted for disposal after the cementing process by drilling out of the obstruction means. In other arrangements however the obstruction means may be adapted for disposal in other ways, for example it may be adapted to disintegrate, or to be displaced as soon as it has performed its function of interrupting the cement displacement plug. In yet other arrangements the obstruction means may be constructed to re-

main in the tubular joint permanently or semi-permanently after it has effected interruption of the plug.

It is preferred that the said tubular component or joint has along at least a portion of its length an inner diameter less than the inner diameter of the tubular structure in which the component is adapted to be coupled in operation. The said lesser inner diameter may be provided along the whole length of the tubular joint, but it can be that the obstruction means is provided by a portion of the tubular joint having a lesser inner diameter than the inner diameter of the remainder of the tubular joint. Most conveniently, the obstruction means is provided by a lining along at least part of the inner surface of the tubular joint of a material different from the material of the wall of the tubular joint, the material of the lining being chosen to allow easy removal if necessary by drilling out at a later stage of operation, for example after the cementing process is completed. Examples of preferred materials for obstruction means are natural or synthetic rubber, or synthetic plastics material, and conveniently the material is bonded to the wall of the tubular joint.

In other forms of the tubular component according to the invention, the obstruction means may comprise projections extending inwardly from the wall of the tubular component, for example, flanges, studs, lugs, fluting or other projections.

In accordance with one preferred arrangement according to the invention, as an alternative to or in addition to the lining mentioned above, the obstruction means may comprise a web, spider or other form of bridging member extending across the tubular component and adapted to interrupt the passage of the plug member through the tubular component, but adapted to be broken by the plug member so as to allow the plug member to proceed past the bridging member after the said interruption. Conveniently the bridging member comprises a moulded rubber cross positioned across the tubular component at the upper end thereof. Such a rubber cross may be arranged to be breakable by a fluid displacement plug driven by a pressure of displacement fluid in the range 600 to 800 p.s.i. (lbs/sq. inch), conveniently 700 p.s.i.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:–

Figures 1 and 2 are diagrammatic sections showing a casing joint embodying the invention, Fig. 1 showing the joint positioned in a well bore during a cementing operation;

Figures 3 and 4 show corresponding diagrammatic sections of a drill pipe during a cementing operation; and

Figures 5a and 5b show in diagrammatic form a modified tubular component including a rubber bridging member.

In Fig. 1 there is shown a well bore or formation 11 cut in rock or other ambient material 12 and terminating at a base 13 of the formation. Within the bore 11 is a casing string indicated generally at 14 and composed of a number of casing joints of which 4 are shown at 15, 16, 17 and 18. The casing joints are interconnected by threaded sleeves 19, and the bottom casing joints 18 is terminated by a float shoe or float valve 20.

The formation 11 in Fig. 1 is shown at stage at which the drill string (not shown) has been removed after drilling a stage down to the base 13, and the casing string 15 has been inserted in the bore 11 to leave between the outer surface of the casing string 15 and the inner surface of the formation 11 an annular space 21 initially filled with a packing fluid 22. Inside the casing string 14 has been pumped a calculated volume of cementing fluid 23 which has been forced down the casing string 14 by a displacement plug 24 driven along the casing string 14 by a displacement fluid 25 behind the plug 24. As shown, the cementing fluid 23 has been forced around the bottom of the float shoe 20 and back up the annular space 21 to reach a level approximately the same as the level of cementing fluid 23 within the casing string 14. At this stage the pressure detected at the surface by monitoring the pressure in the pumping system changes from an initial negative pressure to a positive pressure as the cement fluid in the annular space 21 passes the cement fluid in the inside of the casing string 14.

Connected in the casing string 14 is a casing joint 16 embodying the present invention and including an obstruction means formed by an inner rubber lining 26 extending along part of the length of the casing joint 26. As shown in Fig. 2, the lining 26 extends along most of the length of the casing joint 16, and provides an inner diameter at the lining of lesser diameter than the inner diameter of the casing 16 at top and bottom portions 27 and 28. The inner diameter of the casing joint 16 at the regions 27 and 28 is conveniently the same inner diameter as for other casing sections in the stage of the casing string.

Conveniently the lining 26 is of natural or synthetic rubber and is bonded to the interior of the steel casing joint 16. By way of example, where the outer diameter of the casing joint 16 is 30in., the thickness of the lining 26 may be 2½in. For example where the inner diameter of the casing joint 16 in the regions 27 and 28 is 26½in., the inner diameter at the lining 26 may be 21½in. Further by way of example the length of the casing joint 16 may be 120in., and the length of the lining 26 may be about 19in.

As shown in Fig. 1 the displacement plug 24 comprises a central metal core 29, for

example of aluminium, carrying four rubber cone-shaped sealing members 30 which are of a diameter such as to press outwardly against the inner surface of the casing string 14, and effect a seal therewith.

When the plug 24 reaches the lining 16 it experiences a momentary check or interruption to its movement along the casing string 14 while the pressure in the displacement fluid 25 rises sufficiently to carry the plug 24 past the lining 24 and onwards down the casing string 14. The extent of this interruption to the plug movement, for example as to whether the plug comes to rest or merely slows in its movement, will depend upon the depth of the lining 26, and the resilience or design of the cones 30 on the plug 24. The effect of the interruption of the plug movement is a pressure surge in the pumping system which is detected at the surface pumping equipment.

In operation the method of the embodiment of the invention shown operates in the following manner. Firstly there is deposited into the casing string 14 the quantity of cementing fluid 23 which is calculated to provide the required height of cement up the outer annular space 21. Next there is inserted in the top of the casing string 14 the displacement plug 24, and the plug is driven down the casing string 14 by pressure of the displacement fluid 25. The number of strokes of the pumping apparatus (not shown) is counted from the start of the movement of the plug 24 from the top of the casing string 14 (constituting a known reference position) and the pressure in the pumping system at the surface is monitored until the pressure surge is detected which results from the interruption of the plug movement by the obstruction means 26. Conveniently at this stage the pumping operation can be stopped and the required relationship between the number of pump strokes counted and the volume of displacement fluid pumped (calculated from the known distance of the lining 26 from the surface) is determined. This calibration factor is then applied to the volume of displacement fluid required to fill the remainder of the casing string 14 down to the float shoe 20 (previously calculated from the known length of the casing string 14) to give a number of pumping strokes required to complete the operation. The pumping is then restarted and continued for the required number of strokes, which brings the plug 24 to seat and seal on the float shoe 20.

The cementing fluid is then left to harden around the outside of the casing string 14, and the stage of casing is completed. When the next stage of drilling is to commence the new, narrower, drill bit is lowered down the inside of the casing string, and is easily able to drill away the lining 26, which is made of material suitable to allow easy removal at this stage. As in conventional drilling operation, the drill bit then drills through the float shoe 20 and through the small amount of cement remaining at the base 13.

It is to be appreciated that the method and apparatus according to the invention which has been described finds many uses outside the specific example of cementing a casing stage which has been described. For example, well cementing may be used to line, seal, locate or strengthen a formation at critical points along the bore, or for example in repairing damage to an operating well. The present invention finds application in these situations. Such repair work is known as secondary cementing whilst the cementing process described in the specific example is known as primary cementing.

An example of another such cementing process will now be described with reference to Figs. 3 and 4.

In Fig. 3 there is shown a well bore or formation 111 cut in rock or other ambient material 112 and terminating at a base 113 of the formation. Within the bore 111 is a drill string indicated generally at 114 and composed of a number of drill joints of which three are shown at 115, 116 and 118. The drill joints are interconnected by threaded portions 119, and the bottom drill joint is terminated by a drill head shown diagrammatically at 120.

The formation 111 in Fig. 3 is shown at a stage at which the drill string 114 is to be removed from the bore after there has been deposited at the base 113 of the bore cementing fluid 123. Between the outer surface of the drill string 114 and the inner surface of the formation 111 is an annular space 121 initially filled with a packing fluid 122. Inside the drill string 114 has been pumped a calculated volume of cementing fluid 123 which has been forced down the drill string 114 by a displacement plug 124 driven along the drill string 114 by a displacement fluid 125 behind the plug 124. The cementing fluid 123 has been forced (through apertures not shown) around the bottom of the drill head 120 and back up the annular space 121 to reach a level approximately the same as the level of cementing fluid 123 within the drill string 114.

Connected at or the near the bottom of the drill string 114 is a drill joint 116 embodying the present invention and including an obstruction means formed by an inner rubber lining 126 extending along most of the length of the drill joint 116. As shown in Fig. 4, the lining 126 extends along almost all of the length of the joint 116, and provides an inner diameter at the lining of lesser diameter than the inner diameter of the joints forming the rest of the drill string 114.

Conveniently the lining 126 is of generally similar material and configuration to the lining 26 shown in Figs. 1 and 2. However a lower

edge 132 of the lining 126 differs from that of the lining 26. The lining 26 of Fig. 2 has chamfered edges at its upper and lower edges. An upper edge 131 of the lining 126 is again chamfered to allow relatively easy (although interrupted) passage of the plug 124, but the lower edge 132 of the lining 126 is a square shoulder for preventing return of the plug 124 back up the drill string 114.

As shown in Fig. 3 the displacement plug 124 is generally similar to the plug 24 shown in Fig. 1. When the plug 124 reaches the lining 126 it experiences a momentary check or interruption to its movement along the string 114 while the pressure in the displacement fluid 125 rises sufficiently to carry the plug 124 past the lining 126. The effect of the interruption of the plug movement is a pressure surge in the pumping system which is detected at the surface pumping equipment and is used as described hereinbefore to determine when the required displacement of cementing fluid has been achieved.

In operation the method of the embodiment of the invention shown in Figs. 3 and 4 operates in the following manner. Firstly there is deposited into the drill string 114 the quantity of cementing fluid 123 which is calculated to provide the required depth of cement at the base 113 of the bore 111. Next there is inserted in the top of the drill string 114 the displacement plug 124, and the plug is driven down the drill string 114 by pressure of the displacement fluid 125. When the plug 124 reaches the bottom of the drill string 114, the pumping system is switched off and the drill string 114 is withdrawn from the bore 111 leaving the cementing fluid at the base 113 of the bore 111 to harden as required. After the pumping system has been shut off (during the withdrawing of the drill string), the cementing fluid is prevented from passing back up the drill string 114 by the plug 124 lodging against the shoulder at the lower edge 132 of the lining 126.

In Figs. 5a and 5b there is shown a modification of the drill joint 116 shown in Fig. 4. In Figs. 5a and 5b, elements corresponding to elements in Fig. 4 are indicated by like reference numerals. The modification of the drill joint showing Figs. 5a and 5b consists of the provision at the upper end of the drill joint 116 of a moulded rubber bridging element 133 in the form of a cross which extends across the drill joint 116 at the top of the rubber lining 126. The purpose of the rubber cross 133 is to provide additional obstruction means for producing an interruption of the movement of the displacement plug member 124 (Fig. 3) when it reaches the drill joint 116. In the case of the modification, it is intended that the plug 124 is interrupted in its movement, but then breaks through the rubber cross 133 and continues its way down the drill joint 116. The rubber cross 133 is conveniently arranged to be broken by a fluid displacement plug 124 when driven under a pressure of displacement fluid of about 700 p.s.i. It is to be appreciated that the modification of Figs. 5a and 5b may equally well be applied with the embodiments shown in Figs. 1 and 2. Also the bridging member 133 may be used alone or in combination with other obstruction means with a drill joint or other tubular casing member.

CLAIMS

1. A method of monitoring the pumping of fluid along a tubular structure in a bore of a well, comprising the steps of

driving a movable plug member along a tubular structure in a bore of a well by a pumping system pumping fluid under pressure behind the plug member,

interrupting the passage of the plug member along the tubular structure by an obstruction means placed at a known distance along the tubular structure, and

detecting a surge of pressure in the pumping system resulting from the said interruption of the movement of the plug member to indicate the position of the plug member at the time of detection of the pressure surge.

2. A method according to Claim 1 applied in calibrating a pumping system for pumping fluid along a tubular structure in a bore of a well, the method comprising the steps of

driving the said plug member along the said tubular structure in a bore of a well from a known reference position by pumping displacement fluid under pressure behind the plug member,

interrupting the passage of the plug member along the tubular structure at a known distance from the said reference position,

detecting a surge of pressure in the pumping system resulting from the interruption of the passage of the plug member, and

measuring a working parameter of the pumping system from the time of plug member movement from the said reference position to the time of detection of the said pressure surge to provide a measure of the said working parameter related to a known volume of displacement fluid corresponding to the said known distance along the tubular structure.

3. A method according to Claim 2 in which the said measurement of working parameter consists of a count of pumping strokes producing the said pumping of displacement fluid.

4. A method according to Claim 1, 2, or 3 in which the said plug member comprises a fluid displacement plug member suitable for displacing cementing fluid along the tubular structure, and the step of driving the movable plug member along the tubular structure includes displacing cementing fluid along the tubular structure in front of the plug member.

5. A method according to Claim 1 applied in carrying out a cementing operation in a bore of a well, the method comprising the steps of

forcing cementing fluid along a tubular structure by a fluid displacement plug member driven along the tubular structure by a pumping system pumping a displacement fluid under pressure behind the plug member,

interrupting the passage of the plug member along the tubular structure by an obstruction means placed at a known distance along the tubular structure,

detecting a surge of pressure in the pumping system resulting from the said interruption of the plug member movement to indicate the position of the plug member, and

terminating the cementing operation in dependence upon detection of the said pressure surge.

6. A method of depositing cement in a bore of a well comprising the steps of

forcing cementing fluid along a tubular structure by a fluid displacement plug member driven along the tubular structure by a pumping system pumping a displacement fluid under pressure behind the plug member, and

driving the plug member past an obstruction means placed in the tubular structure at or in the region of the bottom of the well bore and having a shape such as to prevent or inhibit return of the plug member along the tubular structure past the obstruction means.

7. A tubular component for use in a tubular structure in a bore of a well, the tubular component having obstruction means for interrupting passage through the tubular component of a plug member during pumping of fluid through the tubular component.

8. A tubular component for use in a tubular structure in a bore of a well, the tubular component having obstruction means shaped to allow passage through the tubular component of a fluid displacement plug member during pumping of the fluid through the tubular component, but shaped to prevent or inhibit return of the plug member past the obstruction means under the influence of fluid displaced from the tubular structure by the plug member.

9. A tubular component according to Claim 7 or 8 in which the said tubular component has along at least a portion of its length an inner diameter less than the inner diameter of the tubular structure in which the component is adapted to be coupled in operation, the said lesser inner diameter being produced by means of a lining along at least part of the inner surface of tubular component.

10. A tubular component according to Claim 9 in which the said lining is formed of a material different from a material of the wall of the tubular component, the material of the lining being chosen to allow easy removal if necessary by drilling out at a latter stage of operation.

11. A tubular component according to Claim 7, 8, 9 or 10 in which there is provided a bridging member extending across the tubular component and adapted to interrupt the passage of the plug member through the tubular component, but adapted to be broken by the plug member and to allow the plug member to proceed past the bridging member after the said interruption.

12. A method of determining the position of a movable plug member along a tubular structure in a bore of a well, substantially as hereinbefore described with reference to Figs. 1 and 2 or Figs. 3 and 4 or Fig. 5 of the accompanying drawings.

13. A method of calibrating a pumping system for pumping fluid along a tubular structure in a bore of a well substantially as hereinbefore described with reference to Figs. 1 and 2 or Figs. 3 and 4 or Fig. 5 of the accompanying drawings.

14. A method of carrying out a cementing operation in a bore of a well substantially as hereinbefore described with reference to Figs. 1 and 2 or Figs. 3 and 4 or Fig. 5 of the accompanying drawings.

15. A tubular component for use in a tubular structure in a bore of a well substantially as hereinbefore described with reference to Figs. 1 and 2 or Figs. 3 and 4 or Fig. 5 of the accompanying drawings.

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